OBSERVATIONS ON THE BIOLOGY OF TIPULA FOOTEANA ALEXANDER (DIPTERA: TIPULIDAE)

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During the Spring of 1959, several fourth instar larvae of a species of *Tipula* were collected from a mudflat bordering Robinson's Lake in Latah County, Idaho. Later, the laboratory-reared and feral adults were forwarded to Dr. C. P. Alexander, who subsequently described them as representing a new species (1961, Great Basin Nat. 21: 11). The purposes of the present paper are to present observations on the life history and to give descriptions of the immature stages.

The larval habitat consists of an extensive mudflat lying along the northeast shore of Robinson's Lake on either side of the small inlet stream. The shallow lake, located approximately eight miles east of Moscow, was formed during the 1930's by damming a small southflowing stream. Although the eastern and western shores of the lake are partially wooded, the mudflat itself is unshaded and during the summer months supports a lush growth of reed canary grass (*Phalaris arundinacea* L.). The larvae were most abundant among the roots of this grass, although a few were discovered several feet away from any vegetation. All were taken in the upper two inches of soil, and a few were located by the slight surface ridges produced as they progressed through the mud.

Numerous larvae were discovered on March 27, several more were collected on April 25, but none were found during a two-hour search of the habitat on May 10. No pupae or pupal exuviae were discovered before April 5, they were abundant by April 25, but only a few were obtained after May 10. Adults began to appear during mid-April, became very abundant during late April and early May, but had largely disappeared by early June. No adults were seen during numerous trips to the mudflat during the summer and fall months. The collecting records indicate that *footeana* is univoltine, with overwintering apparently occurring as last instar larvae. Pupation takes place during April, with adults reaching a peak of abundance during late April and early May.

Teneral females were found to contain large numbers of apparently mature eggs, and, in the laboratory, adults mated within two days after emerging from pupae. Oviposition generally took place within four days after emergence.

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Efforts to rear larvae in the laboratory were only partially successful as a complete life cycle was not obtained. On May 10, a female taken in copula at the mudflat was transferred to the laboratory at the University of Idaho. After the head, legs and wings were removed, she was floated on a slight amount of water in a small Petri dish (see Laughlin, 1958, Entomol. Exp. and Appl. 1: 241–245, for a discussion of this technique). Egg-laying began quickly and within an hour 51 eggs had been obtained. No additional oviposition occurred until the following day when her abdomen was torn slightly by cutting the pleural membrane near the thoracic-abdominal junction. Within three hours after this treatment, she produced an additional 149 eggs. Dissection two days later disclosed that all of the mature eggs had been deposited.

The eggs possess a coiled, thread-like filament at the end opposite the micropyle. When placed in water, the filament gradually uncoils and then resembles a pale thread extending approximately one centimeter from the egg. According to Robinson (1956, Proc. Univ. Durham Phil. Soc. 12: 175–182) terminal filaments are found on eggs of species that oviposit in habitats where there is a danger of the eggs being washed away. He believes that the partially uncoiled filament reduces this possibility by becoming entangled in stationary debris and acting as an anchor. Certainly the mudflat at Robinson's Lake is subjected to periodic flooding, and the anchoring function ascribed to the terminal filament would seem to have considerable survival value.

Approximately 150 eggs were placed on moist filter paper in small Petri dishes and allowed to develop at room temperatures. The remaining eggs were preserved. Hatching began on May 16, six days after eggs were deposited, and continued until May 18. Only 55 of the 150 eggs hatched, the remainder became covered by mold and were obviously inviable. Hatching occurred from the micropylar end of the egg.

Dried powdered grass was added to the dishes containing newly hatched larvae. This material, when moistured, was fed upon readily, and larval growth was fairly rapid. Ten larvae molted into the second instar on May 24 and 25, giving a first larval stadium lasting eight to nine days. Two second instar larvae molted again on May 29, giving a second larval stadium of approximately five days. One larva passed into the fourth instar on June 8, indicating that the third larval stadium lasts about ten days. This larva lived for an additional 22 days, but died before pupating. The rearing results indicate that the first three larval stadia are passed through quickly, but that the final larval stadium is greatly lengthened and probably serves as the overwintering stage.

On both March 27 and April 25 larvae of undetermined species of *Tabanus* and *Chrysops* were abundant in the mudflat, along with numerous larvae of dolichopodids and other tipulid genera, particularily *Limonia*. In the laboratory, the *Tabanus* larvae fed voraciously on the fourth instar *footeana* larvae, while the dolichopodids readily attacked the earlier instar larvae. No *Chrysops* larvae were seen feeding on the tipulids.

DESCRIPTIONS OF IMMATURE STAGES

Egg (Fig. 12).—Length 0.98–1.04 mm. ($\bar{\mathbf{x}} = 1.01 \text{ mm.}$); width 1.33–1.41 mm. ($\bar{\mathbf{x}} = 1.38 \text{ mm}$). Elongated-ovoid, with one side more flattened. Chorion shining dark brown to black, without sculpturing. Micropyle subapical on convex side of egg, situated in center of raised, subcircular pit. End opposite micropyle with pale, coiled terminal filament between one and two centimeters in length. (Based on 30 specimens).

First instar larva (unfed)—Length 1.98–2.32 mm. ($\bar{x} = 2.25$ mm.); width 0.35–0.42 mm. ($\bar{x} = 0.40$ mm.). Pale yellow; each segment with darker annulus posteriorly; integument subtransparent, with abundant minute hairs and numerous long, pale setae.

Spiracular disc (Fig. 11) with two lateral and two ventral lobes; each lateral lobe with narrow, dark brown stripe, apex with brush of 15–20 long, pale setae; each ventral lobe lightly pigmented, apex with brush of 10–15 long setae. Dorsal border of disc with eight pencils of paired setae, those nearest midline longest. Anal papillae four, pale, slender and tapering, subequal in length.

Head capsule lightly pigmented; antennae slender and hair-like; mentum with five blunt teeth, median tooth longest. (Based on 10 specimens).

Second and third instar larva—Very similar to fourth instar larva, differing primarily in smaller size and in having less pigmentation on spiracular disc.

Fourth instar larva (Figs. 1–10).—Length 30.0 to 36.0 mm. ($\bar{x} = 34.0 \text{ mm}$); width 3.0 to 3.5 mm. ($\bar{x} = 3.2 \text{ mm}$). Yellowish brown to grayish brown in color, with vague indication of middorsal stripe running length of abdomen, paler ventrally; color fading in specimens preserved in alcohol. Cuticle densely clothed with hairs; dorsum of fifth abdominal segment with hairs arranged in short lines with ends of lines indistinct (Fig. 7A); lines of hairs more widely spaced along middorsal line. Numerous longer hairs around base of setae D2-4 and D5 (Fig. 7). Lateral region with abundant scattered short hairs, these not arranged in lines or only vaguely so, without clusters of long hairs. Venter with short hairs arranged in transverse lines similar to dorsal pattern, with weak cluster of longer hairs slightly anterior to setae V1–V3.

The chaetotaxy, very similar to that illustrated for *Tipula flavolineata Meigen* (Chiswell, 1956), is as follows. Dorsum of prothorax (Fig. 1) with seven setae arranged in two rows; in anterior row D2 and D3 arise close together, D3 longer than D2, D1 short; in posterior row D6 and D7 arise close together, D6 longest. Lateral region with eight setae: L1 very short and close to L2, L3, L4, and L5 close together, L8 very short and close to anterior margin of segment. Venter with six setae; V1–V4 very close together, V3 and V4 about twice length of V1 and V2, V5 and 6 closer to mid-



Structures of fourth instar larva of *Tipula footeana* Alex. Fig. 1, Chaetotaxy of prothorax. Fig. 2, Chaetotaxy of mesothorax and metathorax. Fig. 3, Chaetotaxy of first abdominal segment. Fig. 4, Chaetotaxy of abdominal segments two through seven. Fig. 5, Lateral view of eighth abdominal segment. Fig. 6, Posterior spiracular disc. Fig. 7, Dorsum of fifth abdominal segment showing chaetotaxy and distribution of microhairs; A, Enlarged view of portion of dorsum. Fig. 8, Antenna. Fig. 9, Hypopharynx. Fig. 10, Mentum. ventral line and with V6 anterior to V5. Setal patterns of mesothorax and metathorax very similar to each other (Fig. 2). Dorsum of each segment with five bristles; D2 and D3 long and nearly contiguous, D4 and D5 close together, D5 slightly longer than D4. Lateral region with six setae. Venter with five setae, V1–V4 very close together, V1 shortest, V5 near midventral line and slightly anterior to V1–V4.

First abdominal segment shorter than remaining segments, with setae arising near its mid-length (Fig. 3). Dorsum with six setae arranged in anterior row of two (D5 and D6) and posterior row of four (D1–D4), with D2 and D3 close together and closer to D4 than to D1. Lateral region with four setae, L1–L3 fairly close to-



Fig. 11, Posterior spiracular disc of first instar larva. Fig. 12, Egg.

gether, L4 more anterior, L2 and L4 longer than L1 and L3. Venter with five setae, V1–V3 close together, V4 and V5 slightly anterior to V1–V3, V3 and V4 longer than other setae. Abdominal segments two through seven each divided into long anterior and short posterior annuli. Setal patterns similar, with all setae except L4 arising on posterior annuli (Fig. 4). Six dorsal setae on each side arranged in two rows, D2 and D3 close together; four lateral setae, L1–L3 in small triangle with apex directed posteriorly, L1 short, L4 far forward near margin of segment; five ventral setae, V1-V3 close together, V1 shortest, V4 and V5 anterior of V1-V3. Eighth abdominal segment with spiracular disc on posterior surface (Fig. 5). Each dorsal lobe of disc without setae on anterior surface; each lateral lobe with one long seta on anterior face near midlength; each ventral lobe with one very short seta near apex, one long seta at mid-length, two slightly shorter setae along ventral margin and four setae on base. Each dorsolateral surface of segment with two long setae anterior to bases of dorsal and lateral lobes, more anterior seta partially surrounded by short hairs; each lateral surface with long seta anteriorly; each ventrolateral surface with two setae near midventral line anterior to anal field.

Spiracular disc (Fig. 6) with dorsal and lateral lobes subequal in length and width, ventral lobes somewhat shorter and broader. Lobes with numerous marginal hairs. Each dorsal lobe with pigmented marginal stripes, stripes broader at bases of lobes; each lateral lobe with central dark stripe ending before apex of lobe; each ventral lobe with pigmented marginal stripes that join at base of lobe, with elongate black spot near apex and with small transverse dark spot at base. Posterior surface of disc glabrous except for numerous hairs and setae on marginal lobes. Each dorsal lobe with short seta near apex; each lateral lobe with four setae, two close together near apex and two along dorsal margin near base; each ventral lobe with five setae, one long seta arising in clear area at tip of apical dark spot, four shorter setae arising near apex of lobe near marginal hairs. Spiracles subcircular, stigmatic scars black, peritremes brown.

Anal field with six papillae; dorsal ones longest and about four times longer than wide; lateral lobes nearly as long as dorsal lobes; ventral lobes short and bluntly rounded.

Mentum of head capsule with five distinct teeth anteriorly, median tooth largest (Fig. 10); hypopharynx (Fig. 9) with well developed median tooth and two blunt lateral teeth; each antenna (Fig. 8) elongate, with small apical papilla. (Based on 20 specimens).